Jessica Bryne
Regulatory Services
One South Church
PO Box 711
Tucson, Arizona 85702
(520) 884-3680 Office
jbryne@tep.com

UniSourceEnergy SERVICES

ORIGINAL

March 13, 2006

Docket Control
Arizona Corporation Commission
1200 W. Washington
Phoenix, Arizona 85007

Re: UNS Electric, Inc. Reliability-Must-Run (RMR) Report for 2004
Docket No. E-00000D-05-0040

Docket Control:

Please find enclosed the 2004 annual Reliability-Must-Run (RMR) Report that is filed with the annual 10-Year plan for UNS Electric, Inc. Also enclosed is an additional copy that the Company requests you date-stamp and return in the self-addressed, stamped envelope for our files.

If you have any questions, please call me at 520-884-3680.

Sincerely,

Jessica Bryne
Regulatory Services

Enclosures: Report

Cc: Brian Bozzo, ACC
Carmela Leon, ACC
Ed Beck, UNS

UniSourceEnergy SERVICES

Long-term Transmission Plans for the Santa Cruz County UNS Electric System

Prepared by the
Tucson Electric Power
Transmission Planning Department
June 2004

Introduction

The Santa Cruz county portion of the Citizen's Communications (formerly Citizen's Utilities) system was acquired by UniSource Energy (UES) in August 2003. The Santa Cruz system consists of a radial 115 kV transmission system fed from the Western Area Power Administration's (WAPA) Nogales Tap substation. Four substations are served by this radial line: Kantor, Canez, Sonoita, and Valencia. Due to the radial aspect of the transmission service, the system is exposed to loss-of-load for 115 kV transmission line faults. In the worst case, the entire system load can be lost due to a single 115 kV fault.

Unfortunately, power outages have occurred in recent years, some of which have been lengthy. The Arizona Corporation Commission subsequently ordered Citizen's, in decision no. 64356, to construct secondary transmission service into the area. The additional transmission is intended to provide redundancy and potentially eliminate loss-of-load for any single transmission-line fault.

As Citizen's was planning for such secondary transmission service, Tucson Electric Power, UniSource Energy's principal subsidiary, was proceeding with plans to build a double-circuit 345 kV line from Tucson to the U.S. / Mexican border at Nogales, Arizona. The line was intended to ultimately connect with the Comision Federal De Electricidad (CFE) system in Mexico. It became apparent, however, that this line could also serve as the necessary second transmission line into the Citizen's Santa Cruz area system.

An agreement was reached with Citizen's to establish a 115 kV tie between the new 345 kV Gateway station near the U.S. / Mexican border and the existing 115 kV Valencia station via a 345/115 kV transformer and a short 115 kV line. Since the UES acquisition of Citizen's, UES has been analyzing the Santa Cruz system to determine if the Gateway – Valencia line is still effective and sufficient for the long-term transmission needs of the Santa Cruz system. This report presents the findings and recommendations of that analysis.

Executive Summary

The existing UES Santa Cruz electric system can support a maximum of 50 MW of load with no Valencia turbines dispatched and up to 95 MW with all three turbines dispatched. This does not take any disturbances (N-0) into account since the system is currently radial from WAPA's Nogales Tap substation. Any disturbance on the 115 kV portion of the Santa Cruz system will result in partial to complete loss of load, at least temporarily, on the system.

This study assumes that the South – Gateway project is in-service. Additionally, three 115 kV transmission line projects were considered that provide various levels of redundancy to the Santa Cruz system.

First, a single line from Gateway 115 kV to Valencia 115 kV was examined. It allows all loads to be served up to 30 MW with no loss of load or WECC criteria violations following any single contingency. Beyond 30 MW a ΔV violation occurs on the Santa Cruz 115 kV system. Dispatching Valencia gas turbines can alleviate the ΔV violations, but this would result in excessive turbine operation and is not economically viable. A more realistic solution may be to dispatch turbines when Santa Cruz load exceeds 50 MW. From the N-0 analysis of the existing system, 50 MW is the maximum load that can be served with the existing system. That would be the equivalent resulting system following the Gateway to Valencia 115 kV outage.

Second, two circuits from Gateway 115 kV to Valencia 115 kV was examined. For true redundancy a second 345/115 kV transformer must also be installed at Gateway substation. Assuming that is the case, up to 75 MW of Santa Cruz system load can be served with no loss of load or WECC criteria violations following any single contingency. Dispatching Valencia gas turbines is ineffective because the critical contingency is loss of Sonoita – Valencia 115 kV; Voltages become depressed on the system north of the outage, but the turbines are south of the outage.

Third, one circuit from Gateway 115 kV to Valencia 115 kV along with one circuit from Gateway 115 kV to Sonoita 115 kV was examined. Again, two 345/115 kV transformers at Gateway were assumed. Up to 110 MW of load can be served with no loss of load or WECC criteria violations following any single contingency. Above 110 MW, the 115/13.2 kV substation transformers begin to overload at Kantor and Canez substations. Additionally, the 115/13.2 kV transformers at Valencia substation begin to overload at system loads above 80 MW, but these overloads can be alleviated by dispatching Valencia gas turbines. These transformers will ultimately need to be replaced with larger-capacity units if the full benefit of this transmission upgrade is to be realized.

Study Assumptions

The 2012 Reliability Must Run (RMR) case was used in the analysis. This case was developed jointly by Salt River Project (SRP), Arizona Public Service (SRP), Southwest Transmission Cooperative (SWTC), and Tucson Electric Power (TEP) last fall and was used in ten-year plan and RMR study work for the ACC. The UES Santa Cruz system was explicitly modeled in the case as well as the South – Gateway 345 kV project. A 400 MW transfer to the CFE system was also modeled as a lumped load on the Gateway 345 kV bus.

Loads for the UES system were modeled at 1.00 power factor. The load power factors are currently leading; this over-correction is an intentional effort to reduce transmission var requirements from Nogales Tap. Therefore, it seemed reasonable that unity power factor can be maintained long-term. Total system load was assumed to be distributed via the following proportions:

Substation	Percentage of Total Load
Kantor	10%
Canez	10%
Sonoita	30%
Valencia	50%
Total	100%

Each load-serving substation transformer on the UES Santa Cruz system has adjacent, but discrete voltage regulators. The GE PSLF analysis software does not have a dedicated voltage regulator model; however, it does permit transformers with load tap-changers (LTC). Therefore, the station transformers were modeled with LTCs. Additionally, it was assumed that all LTCs have a range of ±10% and 5/8% tap step size. The LTCs were set to maintain 1.00 pu voltage within a small control bandwidth.

For the dynamic stability analysis, the 2012 heavy summer WECC dynamics data was used. Dynamics data for the Valencia gas turbines was developed by General Electric during special testing performed in 1999. That data was used in the analysis. Additionally, the loads at the Santa Cruz substations had a 20% motor load component added. This is in accordance with current WECC policy.

Study Methodology

Multiple power flow cases were developed using the GE PSLF analysis program. These cases were all based upon the 2012 RMR case as previously described. Cases were built in 5 MW increments from 20 MW to 120 MW Santa Cruz load. Additionally, cases representing various Valencia turbine dispatches and different 115 kV transmission configurations were considered along with the range in loads.

All single contingencies were analyzed via power flow on the Santa Cruz system. This was done for all power flow cases and any corresponding WECC criteria violations were noted. Specifically, voltage changes greater than 5% or thermal overload conditions were noted. Subsequently, dynamic simulations were performed for a subset of the contingencies. Three-phase faults were applied on various 115 kV segments. All faults were cleared in six cycles.

Results

Power Flow

Existing System -- See fig. 1.
The existing Santa Cruz system was examined for N-0 load-serving capability. The limiting criterion used was substation feeder voltages. Each station was required to maintain 1.0 pu (13.2 kV) nominal voltage. It was assumed that the corresponding feeder end voltage would be approximately 0.95 pu of nominal, the minimum allowed.

Santa Cruz Load (MW)	No. of Valencia Turbines	Limit
50	0	Max LTC @ Valencia
75	1	Max LTC @ Valencia
85	2	Max LTC @ Valencia
95	3	Max LTC @ Valencia

Table 1.
Table of existing load-serving capability

The values in Table 1 are somewhat higher than those presented in a report to the ACC earlier this year. At that time, the load power factor was assumed to be 0.95 lagging. In this study, as stated previously, the power factor is assumed to be 1.00 to reflect operating experience resulting from distribution capacitor bank additions. In general, higher power factor loads translate into less voltage depression so more load can be served.

Please note that Table 1 tabulates the ability to serve load without regard for continuity of service. Since the UES Santa Cruz system is currently a radial system, any 115 kV transmission contingency will result in some loss of load. The subsequent analysis focuses on serving load with regard to continuity of service since the various transmission options loop the Santa Cruz system.

Criteria for Looped Systems

Once the system is looped, additional portions of the WECC and NERC Reliability Criteria become applicable. The NERC has established the following specific criteria for single-contingency outages following the disturbance:

1) All power flows through equipment must not exceed their respective thermal limit.
2) All voltages must remain within defined limits.
3) The system must be dynamically stable.

In addition the WECC specifies that:

1) The instantaneous voltage must not fall below 25% of the pre-fault value at load buses and 30% of the pre-fault value at non-load buses after the fault has been cleared.
2) The instantaneous voltage at any load bus must not fall below 20% of the pre-fault value for more than 20 cycles after the fault has been cleared.
3) The instantaneous frequency at any load bus must not fall below 59.6 Hz for more than 6 cycles .
4) The steady-state voltage at a bus must not deviate more than 5% of its pre-fault value.

Transmission Option #1: Gateway Station with Gateway – Valencia #1 – See fig. 2.

Table 2 summarizes the results of the power flow analysis. All the N-1 violations were due to post-transient voltage violations on one or more 115 kV buses.
The table would imply that even with the Gateway project in-service, at least one turbine would be required for Santa Cruz load above 30 MW. That would constitute an excessive amount of turbine operation, since current peak load is approximately 60 MW, and is not feasible. A more realistic criterion is to dispatch the turbines at the point load can no longer be served after experiencing the critical outage. From the N-0 analysis, this is 50 MW. A ΔV violation would be incurred between 30 MW and 50 MW load, but additional transient stability studies indicate the load should stay on-line. Per WECC criteria rules, UES can violate the criteria for itself, but it cannot cause a violation for a neighboring utility. By permitting this ΔV violation, UES will operate the turbines significantly fewer hours, and no other utility should be affected.

Santa Cruz Load (MW)	No. of Valencia Turbines	Violation	Contingency
30	0	ΔV Violation @ Gateway 115 kV, Valencia 115 kV, Sonoita 115 kV	Loss of Gateway – Valencia #1
55	1	ΔV Violation @ Gateway 115 kV, Valencia 115 kV	Loss of Gateway – Valencia #1
70	2	ΔV Violation @ Gateway 115 kV, Valencia 115 kV	Loss of Gateway – Valencia #1
75	3	ΔV Violation @ Sonoita 115 kV, Canez 115 kV	Loss of Sonoita – Valencia

Table 2
Summary Table of Transmission Option #1 Results

Transmission Option #2: Gateway Station with Gateway – Valencia #1 and Gateway – Valencia #2 – See fig. 3.

Table 3 summarizes the results of this option. The results indicate that after 75 MW, the Valencia turbines are ineffective. This is due to the fact that the critical outage is loss of Sonoita – Valencia with a corresponding ΔV violation at Sonoita. All turbine support is cut off from Sonoita once the Sonoita – Valencia tie is lost.

Santa Cruz Load (MW)	No. of Valencia Turbines	Violation	Contingency
75	0	ΔV Violation @ Sonoita 115 kV	Loss of Sonoita – Valencia
75	2	ΔV Violation @ Canez 115 kV, Sonoita 115 kV	Loss of Sonoita – Valencia
75	3	ΔV Violation @ Canez 115 kV, Sonoita 115 kV	Loss of Sonoita – Valencia

Table 3
Summary Table of Transmission Option #2 Results

Transmission Option #3: Gateway Station with Gateway – Valencia #1 and Gateway – Sonoita – See fig. 4.

Table 4 summarizes the results of this option. The results indicate that all Santa Cruz county load can be served up to 115 MW without dispatching any turbines and up to 120 MW with one turbine. The limit is due to distribution transformer overloads at Canez and Kantor substations. Also, the Valencia distribution transformers will be overloaded when Santa Cruz county load rises above 80 MW with no turbines dispatched. Options regarding the distribution transformer overload issue will be addressed separately.

Santa Cruz Load (MW)	No. of Valencia Turbines	Violation	Contingency
115	0	ΔV Violation @ Valencia 115 kV	Loss of Gateway – Valencia
120	1	Canez 115/13.2 kV and Kantor 115/13.2 kV XFMR Rating Exceeded	N-0 Loading

Note: Valencia 115/13.2 kV transformers are overloaded if Santa Cruz county load exceeds 80 MW without dispatching turbines.

Table 4
Summary Table of Transmission Option #3 Results

It is important to note that all of the previously documented cases assume the capability of isolating faults along all segments of the UNS Santa Cruz 115 kV system. Currently, this is not possible due to lack of circuit breakers at Kantor and Canez substations. Therefore, all load will be lost, at least momentarily, at Kantor and Canez substations for any 115 kV fault between Nogales Tap and Sonoita substations. This is true regardless of

115 kV transmission improvements in the Valencia and Sonoita substation regions. Consequently, an extended 115 kV outage between Nogales Tap and Sonoita substations could be problematic, but several mitigation measures are currently being implemented. Sectionalizing switches are being installed at Kantor. While these switches will not improve continuity of service, it will permit rapid restoration of service following a 115 kV fault. Additionally, a 46 kV line is under construction to connect the TEP Canoa substation to the Kantor substation. This line will provide emergency backup service to Kantor and Canez substations.

Under current plans, for a failure on the Santa Cruz 115 kV system, Kantor and Canez substations will be isolated from Sonoita and Valencia substations. Kantor and Canez will be served via the 46 kV emergency tie as previously described. Sonoita and Valencia substations will be served via the gas turbines at Valencia.

Stability

Table 5 documents the contingencies taken in the dynamic simulation function of the GE PSLF program. The choice of contingencies was determined based upon previous power flow results, and were assumed to be worse case for a given transmission and/or turbine configuration. All outages were stable and no transient voltage or frequency violations occurred. More detailed data, such as stability plots and other information is included in the appendices.

Santa Cruz Load (MW)	Transmission Option No.	No. of Valencia Turbines	Contingency
55	Current Sys.	1	3-ph fault on Gateway-Valencia @ Valencia
70	Current Sys.	2	3-ph fault on Gateway-Valencia @ Valencia
75	Current Sys.	3	3-ph fault on Sonoita-Valencia @ Valencia
75	1	2	3-ph fault on Gateway-Valencia @ Valencia
75	1	2	3-ph fault on Sonoita-Valencia @ Valencia
75	1	3	3-ph fault on Gateway-Valencia @ Valencia
75	1	3	3-ph fault on Sonoita-Valencia @ Valencia
75	2	0	3-ph fault on Gateway-Valencia @ Valencia
75	2	0	3-ph fault on Sonoita-Valencia @ Valencia
115	3	0	3-ph fault on Gateway-Valencia @ Valencia
115	3	0	3-ph fault on Sonoita-Valencia @ Valencia

Note: All faults were 3-phase with 6-cycle simultaneous clearing on both ends of the line.

Table 5

Recommendations

Given the previous analysis results along with the current load forecast for the Santa Cruz system, Transmission Planning has the following recommendations for transmission improvements in the region that will eliminate RMR requirements through a load of 115 MW (at least 20 years):

- Complete the South – Gateway EHV project as soon as possible. It is acknowledged that federal permitting problems are currently delaying the project.

- Install one 345/138-115 kV transformer at Gateway substation and construct a 138 kV line (could be energized at 115 kV) from Gateway substation to Valencia substation. This would be advantageous since the TEP HV system is 138 kV.

- Install circuit breakers at Kantor and Canez substations to permit single contingency fault clearing without loss of load once the Santa Cruz system is looped into Gateway substation.

- Install a second 345/138-115 kV transformer at Gateway and a 138 kV (could be energized at 115 kV) line from Gateway substation to Sonoita substation. The routing should be as geographically independent of the Gateway – Valencia and Valencia – Sonoita lines as practical.

- Replace the Valencia 115/13.2 kV transformers with 138-115/13.2 kV 50 MVA transformers. Depending on the useful life and moving costs of the existing Valencia transformers, relocate them to Kantor and Canez substations (1 each). This will not only provide necessary capacity upgrades, but will facilitate ultimate 138 kV operation of the 115 kV transmission system since these transformers, along with those at Sonoita, are 138 kV capable.

Appendix 1

Santa Cruz Load Forecast Table

Nogales Retail Peak Forecast -- April 2004				
Year	UniSource Forecast (MW)		Year	Extrapolated Forecast (2% growth factor) (MW)
2004	61.4		2021	86.3
2005	63.2		2022	88.0
2006	64.9		2023	89.8
2007	66.5		2024	91.6
2008	68.0		2025	93.4
2009	69.5		2026	95.3
2010	71.0		2027	97.2
2011	72.5		2028	99.1
2012	74.0		2029	101.1
2013	75.4		2030	103.1
2014	76.7		2031	105.2
2015	78.0		2032	107.3
2016	79.3		2033	109.4
2017	80.6		2034	111.6
2018	81.9		2035	113.9
2019	83.3		2036	116.1
2020	84.6		2037	118.5
			2038	120.8
			2039	123.2
			2040	125.7

Table 1

Appendix 2

Figures 1 - 4

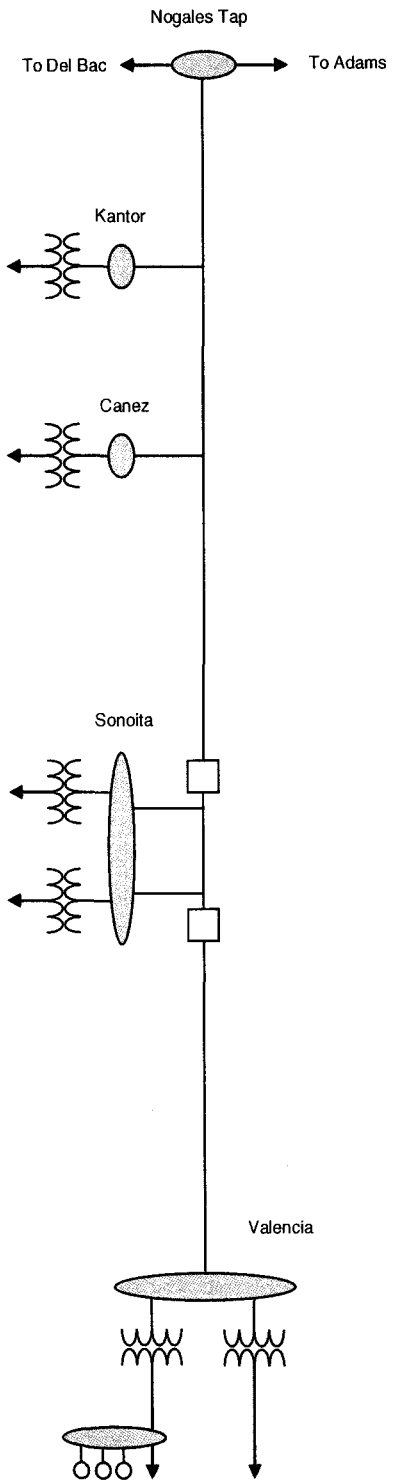

Figure 1
Existing Santa Cruz System

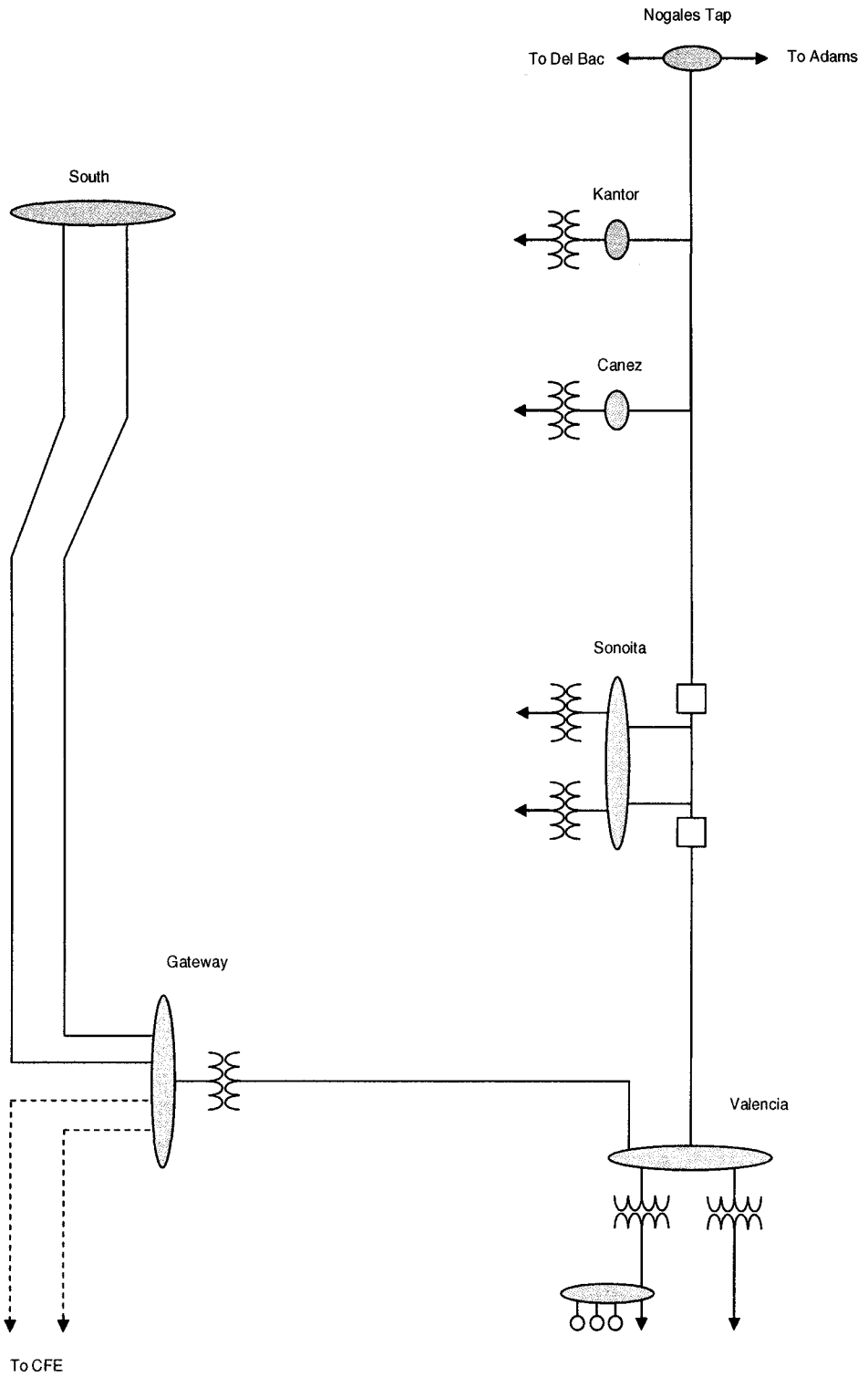

Figure 2
Transmission Option #1
Gateway Station with Gateway – Sonoita #1

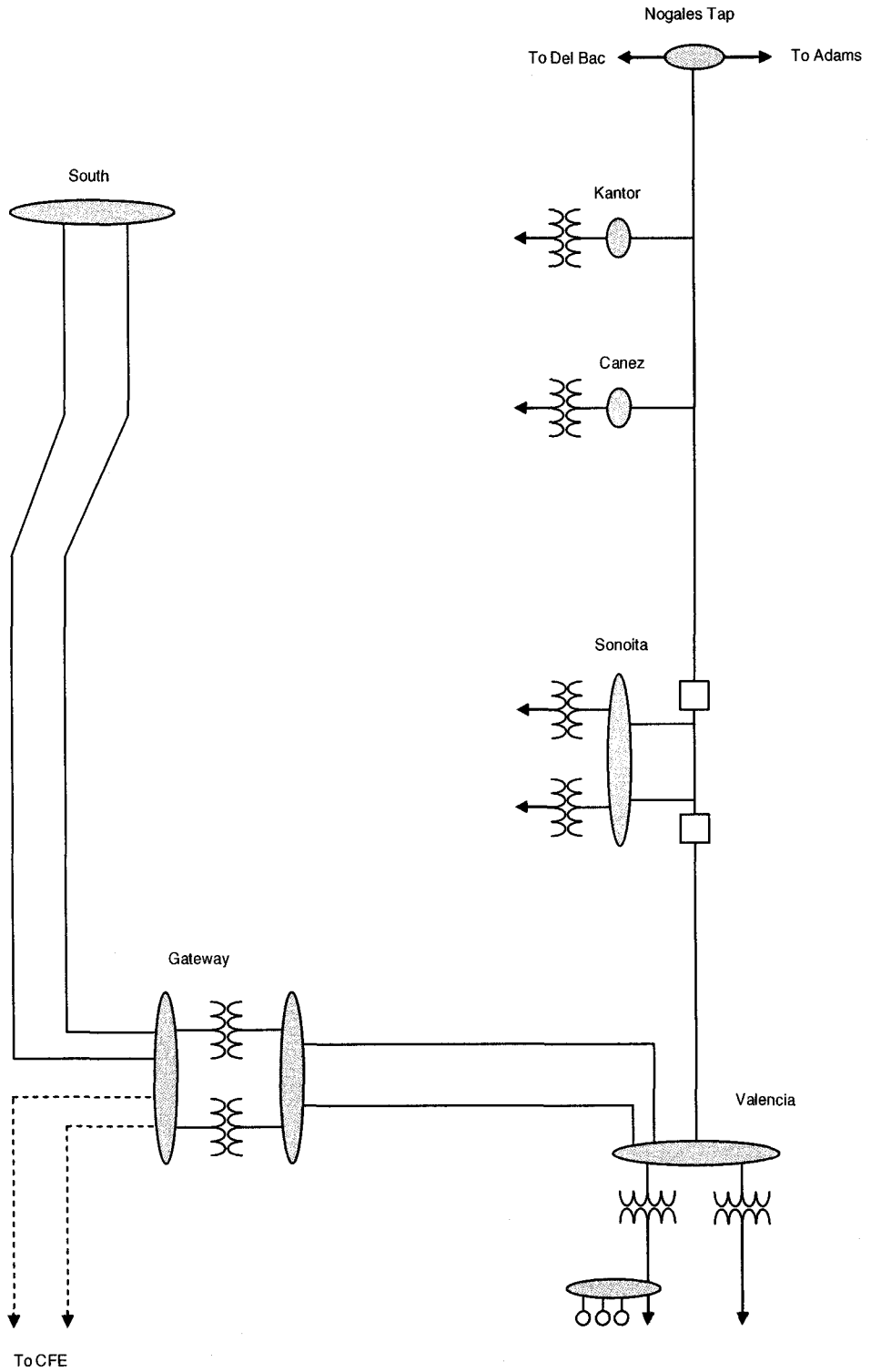

Figure 3
Transmission Option #2
Gateway Station with Gateway – Valencia #1 and #2

```
 0.150000 0.100000   1.5000 0.200000 0.200000 0.0 1.000000 0.0   3.0000 0.020000 /
 0.080000 0.700000 0.0  10.0000 -10.0000 0.0 0.0 1.000000  10.0000 0.100000 /
 0.0
ggov1    16709 "VALNCIA1"  13.20 "3 " : #9 mwcap=16.0000 0.060000 1.000000   2.0000 0.050000 -0.050000  30.0000
5.0000 0.0 1.000000 1.000000 /
 0.150000 0.100000   1.5000 0.200000 0.200000 0.0 1.000000 0.0   3.0000 0.020000 /
 0.080000 0.700000 0.0  10.0000 -10.0000 0.0 0.0 1.000000  10.0000 0.100000 /
 0.0
list of out of service models
#



Power Flow Data for Citizen's Santa Cruz System
# Version   13.1
title
UES (Santa Cruz) Base Case from 2012 RMR Case
Gateway - Sonoita in-service
UES load = 80 MW

!
comments
!
solution parameters
tap     1     tcul  enabled/disabled
phas    1     ps    enabled/disabled
area    1     area  enabled/disabled
svd     1     svd   enabled/disabled
dctap   1     dc    enabled/disabled
gcd     0     gcd   enabled/disabled
jump  0.000290    jumper threshold
toler   0.1000    newton tolerance
sbase    100.0    system mva base
!
bus data  [   11]             ty  vsched   volt     angle    ar zone  vmax   vmin   date_in date_out pid L own
   16700 "KANTOR  " 115.00  :  1 1.00000 1.010641   9.57144  14  161 1.0500 0.9500   400101   391231   0 0  79
   16701 "CANEZ   " 115.00  :  1 1.00000 1.012564   7.99010  14  161 1.0500 0.9500   400101   391231   0 0  79
   16702 "SONOITA " 115.00  :  1 1.00000 1.013552   7.68611  14  161 1.0500 0.9500   400101   391231   0 0  79
   16703 "VALENCIA" 115.00  :  1 1.00000 1.016072   7.51812  14  161 1.0500 0.9500   400101   391231   0 0  79
   16704 "GATEWAY " 115.00  :  1 1.00000 1.017829   7.68093  14  161 1.0500 0.9500   400101   391231   0 0  79
   16705 "KANTOR  "  13.20  :  1 1.00000 1.001979   5.65500  14  161 1.0500 0.9500   400101   391231   0 0  79
```